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## FIFTH ANNUAL MEETING OF THE MATHEMATICAL ASSOCIATION OF AMERICA.

The fifth annual meeting of the Association was held at the University of Chicago on Tuesday and Wednesday, December 28 and 29, 1920, in affiliation with the American Association for the Advancement of Science and in conjunction with the western meeting of the American Mathematical Society. The Illinois Section met jointly with the Association in all its sessions and held a separate business meeting on Tuesday afternoon. There were 204 in attendance at the sessions, including the following 150 members of the Association:

- KATHERINE S. ARNOLD, Milwaukee-Downer College.  
 R. P. BAKER, University of Nebraska.  
 L. A. BAUER, Dept. of Terrestrial Magnetism, Washington, D. C.  
 A. A. BENNETT, University of Texas.  
 VEVIA BLAIR, Horace Mann High School.  
 G. A. BLISS, University of Chicago.  
 HENRY BLUMBERG, University of Illinois.  
 P. P. BOYD, University of Kentucky.  
 F. E. BRASCH, Crerar Library, Chicago.  
 W. D. CAIRNS, Oberlin College.  
 FLORIAN CAJORI, University of California.  
 J. A. CAPARO, Notre Dame University.  
 R. D. CARMICHAEL, University of Illinois.  
 C. C. CARTER, Bluffs, Ill.  
 E. W. CHITTENDEN, University of Iowa.  
 H. E. COBB, Lewis Institute.  
 MYRTLE COLLIER, Southern Branch, University of California.  
 C. E. COMSTOCK, Bradley Polytechnic Institute.  
 I. S. CONDIT, Iowa State Teachers College.  
 H. H. CONWELL, Beloit College.  
 M. W. COULTRAP, North-Western College.  
 A. R. CRATHORNE, University of Illinois.  
 S. E. CROWE, Michigan Agricultural College.  
 D. R. CURTISS, Northwestern University.  
 ALFRED DAVIS, Soldan High School, St. Louis.  
 W. W. DENTON, University of Michigan.  
 L. E. DICKSON, University of Chicago.  
 C. S. DOAN, Purdue University.  
 J. E. DOTTERER, Manchester College.  
 L. W. DOWLING, University of Wisconsin.  
 W. F. DOWNEY, English High School, Boston.  
 ARNOLD DRESDEN, University of Wisconsin.  
 L. C. EMMONS, Michigan Agricultural College.  
 E. B. ESCOTT, Chicago, Ill.  
 J. D. ESHLEMAN, Fellow, University of Chicago.  
 H. J. EITTLINGER, University of Texas.  
 G. C. EVANS, Rice Institute.  
 G. W. EVANS, Charlestown High School, Boston.  
 ZOE FERGUSON, Crane Junior College, Chicago.  
 J. A. FOBERG, Crane Junior College, Chicago.  
 T. M. FOCKE, Case School of Applied Science.  
 A. F. FRUMVELLER, Marquette University.  
 C. D. GARLOUGH, Wheaton College.  
 CORNELIUS GOUWENS, Iowa State College.  
 M. E. GRABER, Morningside College.  
 G. H. GRAVES, Purdue University.  
 W. A. HAMILTON, Beloit College.  
 HARRIS HANCOCK, University of Cincinnati.  
 W. L. HART, University of Minnesota.  
 W. W. HART, University of Wisconsin.  
 E. S. HAYNES, Beloit College.  
 E. R. HEDRICK, University of Missouri.  
 C. L. HERRON, Hillsdale College.  
 T. H. HILDEBRANDT, University of Michigan.  
 F. H. HODGE, Purdue University.  
 T. F. HOLGATE, Northwestern University.  
 J. M. HOWIE, Peru (Neb.) State Normal School.  
 M. H. INGRAHAM, University of Wisconsin.  
 DUNHAM JACKSON, University of Minnesota.  
 L. C. KARPINSKI, University of Michigan.  
 O. D. KELLOGG, Harvard University.  
 A. J. KEMPNER, University of Illinois.  
 A. M. KENTON, Purdue University.  
 E. P. LANE, University of Wisconsin.  
 KURT LAVES, University of Chicago.  
 MRS. MAYME I. LOGSDON, University of Chicago.  
 A. C. LUNN, University of Chicago.  
 MARTHA MACDONALD, Iowa State College.  
 S. L. MACDONALD, Colorado Agricultural College.  
 W. D. MACMILLAN, University of Chicago.  
 GERTRUDE I. MCCAIN, Oxford College for Women.  
 F. M. MCGAW, Cornell College.  
 J. V. MCKELVEY, Iowa State College.  
 MALCOLM MCNEILL, Lake Forest College.

- C. E. MELVILLE, Clark University.  
 E. B. MILLER, Fellow, University of Chicago.  
 G. A. MILLER, University of Illinois.  
 J. A. MILLER, Swarthmore College.  
 W. L. MISER, Armour Institute of Technology.  
 U. G. MITCHELL, University of Kansas.  
 C. N. MOORE, University of Cincinnati.  
 E. H. MOORE, University of Chicago.  
 E. J. MOULTON, Northwestern University.  
 F. R. MOULTON, University of Chicago.  
 J. R. MUSSELMAN, Johns Hopkins University.  
 G. W. MYERS, University of Chicago.  
  
 C. A. NELSON, Western Reserve University.  
 M. J. NEWELL, Evanston Township High School.  
 B. L. NEWKIRK, University of Minnesota.  
  
 H. L. OLSON, University of Michigan.  
  
 C. I. PALMER, Armour Institute of Technology.  
 H. R. PHALEN, Armour Institute of Technology.  
 A. D. PITCHER, Western Reserve University.  
 L. C. PLANT, Michigan Agricultural College.  
  
 PATRICK RAFFERTY, College of the Holy Cross.  
 S. E. RASOR, Ohio State University.  
 H. L. RIETZ, University of Iowa.  
 W. J. RISLEY, James Millikin University.  
 MARIA M. ROBERTS, Iowa State College.  
 W. H. ROEVER, Washington University.  
 IRWIN ROMAN, Northwestern University.  
 D. A. ROTHROCK, Indiana University.  
  
 RALEIGH SCHORLING, Lincoln School.  
 IDA M. SCHOTTENFELS, Chicago, Ill.  
 E. W. SCHREIBER, Proviso Township High School, Haywood, Ill.  
 A. R. SCHWEITZER, Chicago, Ill.  
 G. T. SELLEW, Knox College.  
 W. H. SHERK, University of Buffalo.  
 W. G. SIMON, Western Reserve University.  
 E. B. SKINNER, University of Wisconsin.  
 H. E. SLAUGHT, University of Chicago.  
 D. E. SMITH, Columbia University.  
  
 SAINT MARY-OF-THE-WOODS COLLEGE, Sister Catherine Therese, official representative.  
 CREIGHTON UNIVERSITY, W. F. Rigge, official representative.  
  
 E. R. SMITH, Pennsylvania State College.  
 G. W. SMITH, University of Kansas.  
 H. L. SMITH, University of Wisconsin.  
 I. W. SMITH, North Dakota College.  
 M. G. SMITH, Greenville College.  
 G. G. SPEEKER, Michigan Agricultural College.  
 G. C. STALEY, Parker High School, Chicago.  
 L. L. STEIMLEY, University of Illinois.  
 R. B. STONE, Purdue University.  
 E. B. STOUTER, University of Kansas.  
  
 E. H. TAYLOR, Eastern Illinois State Normal School.  
 W. H. TAYLOR, University of Arkansas.  
 E. L. THOMPSON, Joliet Junior College.  
 F. C. TOUTON, Wisconsin State Department of Education.  
 E. J. TOWNSEND, University of Illinois.  
 BIRD M. TURNER, University of Illinois.  
 H. W. TYLER, Massachusetts Institute of Technology.  
  
 P. H. UNDERWOOD, Ball High School, Galveston, Texas.  
  
 J. N. VAN DER VRIES, U. S. Chamber of Commerce, Chicago.  
 R. N. VAN HORNE, Morningside College.  
  
 WARREN WEAVER, University of Wisconsin.  
 W. P. WEBBER, University of Pittsburgh.  
 EULA A. WEEKS, Cleveland High School, St. Louis.  
 F. M. WEIDA, University of Iowa.  
 C. W. WESTER, Iowa State Teachers College.  
 W. D. A. WESTFALL, University of Missouri.  
 MARION B. WHITE, Carleton College.  
 E. J. WILCZYNSKI, University of Chicago.  
 C. E. WILDER, Northwestern University.  
 D. T. WILSON, Case School of Applied Science.  
 R. E. WILSON, Northwestern University.  
 C. C. WYLIE, University of Illinois.  
  
 C. H. YEATON, School of Engineering of Milwaukee.  
 JESSICA M. YOUNG, Washington University.  
 J. W. YOUNG, Dartmouth College.  
  
 W. A. ZEHRING, Purdue University.

The meetings of the various scientific organizations were held in the buildings of the University of Chicago; thus there was readiness of access to a great variety of programs as well as to the three lectures on the general program of the American Association for the Advancement of Science, viz., "Twenty-five years of bacteriology—A fragment of medical research" by the retiring president, Dr. Simon Flexner, "The volcanic region of Katmai, Alaska" by Dr. R. F. Griggs, and "High power phosphorescence and fluorescence" by Professor R. W. Wood. Opportunity was afforded to visit on Wednesday afternoon the plant of Sears,

Roebuck and Company, and on Thursday afternoon the new Field Museum and the Newberry Library. The visiting ladies were pleasantly entertained on Thursday afternoon at Ida Noyes Hall by the director, Mrs. Goodspeed. Ample cafeteria service was afforded on the campus, and many small groups lunched each day at the Quadrangle Club.

On Wednesday evening the large number of 167 persons shared in the joint dinner of the Society, the Association, Section A of the American Association, and the American Astronomical Society. Professor D. E. SMITH acted as toastmaster, and brief speeches were made by Professor G. A. BLISS for the Society, Professor PHILIP FOX for the Astronomical Society, Professor G. A. MILLER for the Association, Professor D. R. CURTISS for Section A, Professor FLORIAN CAJORI for the newly organized Section L, and Mr. VINCENT W. BROWN, a representative of the Chamber of Commerce of St. Louis, who spoke of the necessity of a thorough training in the fundamentals and of a sound basis of mathematics for practically all lines of business. Professor C. I. PALMER exhibited a copy of the 1637 Descartes geometry, which Professor Cajori in his address of Wednesday had said he had never seen; this copy came to Professor Palmer from earlier possession by Professors Sylvester and George Bruce Halsted. At the close of the speeches Professor E. H. MOORE read a reply from Professor Oskar Bolza, expressing appreciation of a joint greeting sent to him by those who attended the mathematical meetings last September.

It is gratifying to note here that the Association, as also the Society, has been invited to affiliate with the American Association for the Advancement of Science, and on this basis the Secretary-Treasurer took part in that association's Council meeting on Thursday morning, at which Professor E. H. MOORE was elected president of the American Association for the next year.

On motion of Professor Rietz at the final session, the Association adopted by a rising vote a resolution expressing appreciation of the courtesy and cordial welcome extended by the department of mathematics of the University of Chicago and of the work of the local committee that contributed so much to the very successful meetings.

The program for the various sessions continued the previous practice of the Association in including expository papers of a fairly elementary character and papers of historical interest. The latter was especially fitting at this time when Section L (Historical and Philological Sciences) of the American Association for the Advancement of Science was being organized. Professor Cajori presided at the Tuesday morning joint session with Section L, Professor Curtiss, retiring vice-president of Section A, at the Wednesday morning joint session, President D. E. Smith on Tuesday afternoon and incoming President Miller on Wednesday afternoon at the sessions of the Association. The following papers were given. Abstracts of most of these follow, the numbers corresponding to the numbers in the lists of titles:

JOINT SESSION OF THE ASSOCIATION WITH SECTION L OF THE AMERICAN ASSOCIATION.

(1) "Geometrical development of analytical ideas" by Professor L. C. KARPINSKI, University of Michigan.

(2) "The anharmonic ratio in projective geometry" by Professor E. B. STOFFER, University of Kansas.

(3) Introductory note on "The Association's ideal for expository papers" by Professor E. J. WILCZYNSKI, University of Chicago.

(4) "The first work on mathematics printed in the New World" by Professor D. E. SMITH, Columbia University.

(1) The purpose of this paper by Professor Karpinski is to show that many of the fundamental ideas of Greek geometry, and of all geometry up to the time of Newton, correspond closely to elementary analytical ideas. Even the proofs are frequently parallel to modern analytical proofs. The problem of the construction of the regular pentagon is closely connected with the historical development of a large portion of the first four books of Euclid; the problem reduces, of course, to the solution of a quadratic equation. The duplication of the cube, algebraically  $x^3 = 2a^3$ , was solved by the Greeks by two intersecting conics. Similarly the trisection of the angle, the regular seven- and nine-sided polygons were recognized by the Arabs as leading to cubic equations, and solved by conics. Even the squaring of the circle led the Greek Hippocrates to a problem on "application of areas," or quadratics. The problems of the infinitesimal and the theory of limits, with the Eudoxian "method of exhaustion" are also strictly analytical in statement.

(2) In line with the increased interest in the unifying concepts of mathematics, Professor Stouffer discussed the fundamental nature of the anharmonic ratio in projective geometry. The development of the anharmonic ratio concept from the time of Euclid was traced briefly and two theorems were stated which show that information concerning a projectivity is equivalent to information concerning anharmonic ratios. These theorems simplify the proof of many propositions of projective geometry. An illustration of this fact was given by the proof of an important theorem on conics. Several concepts of a fundamental nature in geometry were introduced by means of anharmonic ratios in order to show the value of the method.

(3) Professor Wilczynski's paper will appear in full in the April issue of the MONTHLY.

The Association was fortunate in having on the program four papers which were referred to by a number of members as excellent examples of the kind of expository papers which are possible and desirable.

(4) Professor Smith's paper was printed in the MONTHLY for January, 1921.

SESSION OF THE ASSOCIATION.

(5) "Rolle's theorem and its generalizations" by Professor A. J. KEMPNER, University of Illinois.

(6) "Some geometrical aspects of the theory of relativity" by Professor L. W. DOWLING, University of Wisconsin.

(7) Note on "The metric question from the historical standpoint" by Professor L. C. KARPINSKI, University of Michigan.

(5) Professor Kempner's paper dealt with extensions of the theorem that if a real polynomial equation, *i.e.*, an equation  $f(x) = 0$ ,  $f(x)$  a polynomial with real coefficients, has all of its roots real, then the roots of the derived equation are also all real and are separated by the roots of the given equation. He discussed the well-known Gauss-Lucas polygon theorem, according to which for any polynomial equation (with real or complex coefficients) the derived equation has all roots in the smallest convex polygon which can be described in the complex plane around the points representing the roots of the given equation. The extension of these theorems to other types of equations was considered, the various fields in mathematics in which Rolle's theorem is of importance were mentioned, and some outstanding problems were emphasized.

(6) The following is an outline of Professor Dowling's paper: I. *The Coördinate System.* (a) In primitive times. (b) In Ptolemy's day. (c) After Copernicus. (d) After Kepler and Newton. (e) After Lorentz;—the general quadratic form  $g_{ik}\xi_i\xi_k$  and the associated bilinear form  $g_{ik}\xi_i\eta_k$ , together with the group of linear transformations which leave these forms invariant. A study of this group and its system of invariants and covariants constitutes the special theory of relativity.

II. *Minkowski Space-Time.* (a) The postulate of constant velocity of light; other known velocities less than or equal to that of light. (b) The formation of the "light-cone." (x) The quadratic form  $\xi_1^2 + \xi_2^2 + \xi_3^2 - c^2\xi_4^2$  and the associated bilinear form  $\xi_1\eta_1 + \xi_2\eta_2 + \xi_3\eta_3 - c^2\xi_4\eta_4$ , together with the Lorentz transformation which leaves these forms invariant.

III. *Gravitation.* (a) The Principle of Equivalence. (b) A local gravitational field of force generated by the quadratic transformation  $x = \bar{x}$ ,  $y = \bar{y} + m\bar{x}^2$ . (c) Quadratic Differential Forms  $g_{ik}dx_idx_k$ ;—the necessary and sufficient conditions that two such forms shall be equivalent. (d) The Einstein Space-Time as compared with the Minkowski Space-Time;—their non-equivalence.

IV. The mathematical basis of the special theory of relativity lies in the work of Cayley, Sylvester, Salmon in England; Clebsch, Gordan, Aronhold in Germany; Hermite in France; Brioschi in Italy and many others.

The general theory of relativity rests upon the work of Gauss (1827), Lamé (1859), Riemann (1864), Christoffel (*Crelle* 1870), Ricci and Levi-Civita (*Math. Annalen* 1901), Lie (*Math. Ann.* 1884), Maschke (*Transactions A. M. S.* 1900–1903).

(7) This note by Professor Karpinski calls attention to the desirability that the Association actively enroll itself as supporting the meter-liter-gram system in the United States. A quotation from Simon Stevin, the first writer on decimal fractions, reveals the comprehensive appreciation on the part of Stevin of the great use of decimal fractions as applied to weights, measures, and money.

JOINT SESSION OF THE ASSOCIATION WITH THE AMERICAN MATHEMATICAL SOCIETY AND SECTIONS A AND L OF THE AMERICAN ASSOCIATION.

(8) "A decade of American mathematics," Retiring address as chairman of Section A, Professor O. D. KELLOGG, Harvard University.

(9) "Evolution of algebraic notations" by Professor FLORIAN CAJORI, University of California.

(8) The address of Professor Kellogg was a rapid survey of the distribution of the mathematical effort of the decade in America among the various branches of the subject. It contained pleas for greater development of mathematical physics through a more rational attitude of mathematician and physicist each toward the needs of the other; for the more general cultivation of a sense of values; for the development of a sense of obligation of the individual mathematician to support the publication of worthy American monographs, to produce to the best of his ability, and to give greater attention to making his own contributions and his science in general appeal as widely as possible. This address will be printed in *Science*.

(9) Professor Cajori exhibited slides made from early Italian, German, French and English books and manuscripts, as well as from seventeenth, eighteenth and nineteenth century text books, for the purpose of showing the struggle which has been going on between the rhetorical and the purely symbolic tendencies. From the experiences of the past, inferences were drawn which may serve as present and future guides to mathematicians on matters of algebraic symbolism.

SESSION OF THE ASSOCIATION.

(10) "General aspects of the problem of interpolation" by Professor DUNHAM JACKSON, University of Minnesota.

(11) "Construction of double entry tables" by Professor A. A. BENNETT, University of Texas, in charge of the U. S. Ordnance Ballistic Station, Baltimore, Md.

(12) "Certain general properties of functions" by Professor HENRY BLUMBERG, University of Illinois.

(10) In Professor Jackson's paper, it was pointed out that the problem of interpolation is primarily that of determining a function of specified form, most often a polynomial, which takes on given values for a certain number of given values of the independent variable; but that it is important to generalize the notion, at least to the extent of including functions determined by a finite number of given values, whether coinciding absolutely with those values or not. There are indicated then some of the striking analogies, both formal and more profound, between the formulas of interpolation by polynomials and finite trigonometric sums on the one hand, and Taylor's and Fourier's series on the other.

(11) The double entry tables considered by Professor Bennett were tables with numerical entries, which may be regarded as the values of a function  $F(x, y)$  for equally spaced intervals of  $x$  and equally spaced intervals of  $y$ . The original

data are supposed to be (1) not entirely reliable, (2) possible to obtain by observation or computation for preassigned values of the independent variables, but only with difficulty, (3) not subject to any known formal law. The implications of these conditions were discussed. The advantages of using throughout fourth order differences were pointed out in some detail. Finally the use of "central" differences was explained in the construction of double entry tables.

(12) The substance of Professor Blumberg's paper was largely drawn from his 1917 *Annals* paper and his communication to the American Mathematical Society, April, 1919. No technical knowledge beyond the calculus was presupposed from the hearers and the presentation was couched in expository form.

#### MEETING OF THE BOARD OF TRUSTEES OF THE ASSOCIATION.

Eight members were present at each session.

The following 73 persons and 3 institutions, on applications duly certified, were elected to membership:

#### *To individual membership.*

- ANNA H. ANDREWS, Ph.B. (Wesleyan). Teacher, Public High School, Hartford, Conn.
- B. I. BAIDAFF, Licentiat in mat. (Univ. of Jassy, Roumania). Buenos Aires, Argentina.
- J. P. BALLANTINE, A.B. (Harvard). Instr., Penn. State Coll., State College, Pa.
- P. E. BASYE, Univ. of Missouri, Columbia, Mo.
- E. M. BERRY, Ph.D. (Iowa). Instr., Purdue Univ., W. LaFayette, Ind.
- EMILE BOREL, D.Sc. (Paris). Professeur à la Faculté des Sciences de Paris.
- J. W. CALHOUN, A.M. (Harvard). Asso. prof. of appl. math., Univ. of Texas, Austin, Tex.
- R. H. CARPENTER, A.M. (Kansas). Instr., Univ. of Kansas, Lawrence, Kans.
- C. M. CLEVELAND, B.E. in Civil Engg. (Mississippi). Instr. in appl. math., Univ. of Texas, Austin, Tex.
- R. P. CONKLING, A.B. (Cornell). Head of dept. of math., Tech. School; asst. in math., Central C. and M. T. High School, Newark, N. J.
- A. E. COOPER, E. E. (Texas). Instr. in appl. math., Univ. of Texas, Austin, Tex.
- ODYNE O. CORNELL, A.B. (Nebraska). Mangum, Okla.
- M. E. COX, B.S. in M.E. (Clemson Coll.). Asst. prof., Texas A. and M. Coll., College Station, Tex.
- A. S. CROOM, A.B. (Louisville). Acting dean, Harper Coll., Harper, Kans.
- JULIA DALE, A.B. (Transylvania Coll.). Instr., Univ. of Missouri, Columbia, Mo.
- ALICE C. DEAN, A.M. (Rice Inst.). Fellow and acting libr., Rice Inst., Houston, Tex.
- MARY E. DECHERD, A.M. (Texas). Instr., Univ. of Texas, Austin, Tex.
- S. DICKSTEIN. Prof., Univ. of Warsaw, Warsaw, Poland.



- L. H. DUBE, Ph.D., D.D. (Gregorian Univ., Rome); M.Sc. (Ottawa). Prof. of higher math., Ottawa Univ., Ottawa, Can.
- J. R. EVERETT, A.M. (Wisconsin). Instr., Carnegie Inst. of Tech., Pittsburgh, Pa.
- LUCY A. FEDDERSEN, A.B. in Educ. (Wyoming). Instr., Univ. of Wyoming High School, Laramie, Wyo.
- A. R. FEHN, Ph.B. (Baldwin-Wallace Coll.). Asso. prof., Univ. of Wyoming, Laramie, Wyo.
- FLORENCE E. FIELD, A.M. (Michigan). Acting head of dept., Park Coll., Parkville, Mo.
- R. M. FOSTER, B.S. (Harvard). Dept. of development and research, Amer. Tel. and Tel. Co., New York, N. Y.
- J. G. FOWLKES, A. B., B.O. (Ouachita Coll.). Head of dept. of math., Roger Ascham School, New York, N. Y.
- H. J. GAY, A.B. (Harvard). Instr., Worcester Polytech. Inst., Worcester, Mass.
- J. S. GOLD, B.S. (Bucknell). Instr., Bucknell Univ., Lewisburg, Pa.
- P. H. GRAHAM, A.M. (Virginia). Instr., New York Univ., New York, N. Y.
- H. H. HAMMER, A.M. (Texas). Asst. to state actuary, Austin, Tex.
- A. J. HARGETT, A.M. (Transylvania Coll.). Head of dept. of math., Texas Christian Univ., Fort Worth, Tex.
- A. S. HATHAWAY, B.S. (Cornell). Prof., (retired), Rose Polytech. Inst., Terre Haute, Ind. Houston, Tex.
- T. B. HENRY, A.B. (Kansas). Instr., Univ. of Kansas, Lawrence, Kans.
- MABEL M. HEREN, M.S. (Northwestern Univ.). Asst. prof., Knox Coll., Galesburg, Ill.
- T. F. HOLGATE, Ph.D. (Clark), LL.D. (Illinois; Queens). Prof., Northwestern Univ., Evanston, Ill.
- HELMA L. HOLMES, A.M. (Nebraska). Instr. in pure math., Univ. of Texas, Austin, Tex.
- B. P. HOOVER, A. B. (Baker Univ.), Asst. prof., Baker Univ., Baldwin, Kans.
- GOLDIE P. HORTON, Ph.D. (Texas). Instr. in pure math., Univ. of Texas, Austin, Tex.
- C. G. JAEGER, A.B. (Missouri). Instr., Univ. of Missouri, Columbia, Mo.
- L. M. KLAUBER, A.B. in E.E. (Stanford). Genl. supt., Cons. Gas and Electric Co., San Diego, Calif.
- J. J. KNOX, A.B. (Chicago). Instr., School of Eng. of Milwaukee, Milwaukee, Wis.
- F. A. LA MOTTE, M.S. (Chicago); A.M. (Wisconsin). Instr., Junior Coll., St. Joseph, Mo.
- G. L. LOWRY, B.S. (Bucknell). Instr., Bucknell Univ., Lewisburg, Pa.
- ISRAEL MAIZLISH, M.S. (Mass. Inst. of Tech.). Instr. in physics, Reed Coll., Portland, Ore.
- C. E. MELVILLE, A.B. (Northwestern). Asso. prof. and registrar, Coll. dept., Clark Univ., Worcester, Mass.

- D. H. MENZEL, A.B. (Denver). Instr., Univ. of Denver, Denver, Colo.
- A. D. MICHAL, A.B. (Clark Coll.). Fellow in math. and asst. in physics, Clark Univ., Worcester, Mass.
- J. N. MICHIE, A.M. (Michigan). Adj. prof. of appl. math., Univ. of Texas, Austin, Tex.
- PEARL C. MILLER, A.M. (Stanford). Asst., Washington Univ., St. Louis, Mo.
- FANNIE S. MITCHELL, A.B. (N. Car. Coll. for Women). Teacher, High school, Gastonia, N. C.
- ANNA M. MULLIKIN, A.M. (Pennsylvania). Instr., Univ. of Texas, Austin, Tex.
- W. L. PHINNEY, B.S. (Dartmouth). Instr., Worcester Polytech. Inst., Worcester, Mass.
- A. D. PIERSON, B.S. in Ed. (Missouri). Teacher, N. E. High School, Kansas City, Mo.
- C. S. PORTER, A.B. (Amherst). Instr., Worcester Polytech. Inst., Worcester, Mass.
- HUGH PORTER, A.M. (Texas). Asso. prof., N. Texas St. Normal Coll., Denton, Tex.
- CAROLINE M. REAVES, A.M. (Oklahoma). Prof., Coker Coll., Hartsville, S. C.
- N. B. ROSENBERGER, A.M. (Pennsylvania). Grad. student, Teachers Coll., Columbia Univ., New York, N. Y.
- JEAN F. ROSS. Librarian, High school, Sacramento, Calif.
- BERNICE SANDERS, A.B. (Wilberforce). Prof., Wilberforce Univ., Wilberforce, Ohio.
- E. W. SCHREIBER, A.B. (Michigan). Head of dept. of math., Proviso Township High School, Maywood, Ill.
- PINCAS SCHUB, formerly student in Turkey. Fellow, Clark Univ., Worcester, Mass.
- JABIR SHIBLI, A.M. (North Dakota). Prof., Fargo Coll., Fargo, N. Dak.
- F. L. SMITH, A.B. (Drury Coll.) Asst. in physics, Univ. of Missouri, Columbia, Mo.
- R. F. SMITH, M.S. (New York Univ.). Asst. prof., Coll. of City of New York, New York, N. Y.
- G. W. SNEDECOR, A.M. (Michigan). Asso. prof., Iowa State Coll., Ames, Ia.
- MAY J. SPERRY, A.M. (Brown). Instr., Knox Coll., Galesburg, Ill.
- LOUISE E. C. STUERM, A.M. (Columbia). Dept. of development and research, Amer. Tel. and Tel. Co., New York, N. Y.
- J. A. SWENSON, A.B. (Columbia). Head of dept. of math., Wadleigh High School, New York, N. Y.
- O. B. TROUT, A.M. (Denver). Prof. of math. and registrar, Univ. of Denver, Denver, Colo.
- E. R. TUCKER, B.S. (Milit. Coll. of S. C.); A.B. (Texas Chr. Univ.). Asso. prof., Texas Chr. Univ., Fortworth, Texas.
- F. N. WELLS, Instr., U. S. Naval Acad., Annapolis, Md.
- Mrs. F. E. WOOD, A.B. (Baker Univ.). Fellow, Univ. of Kansas, Lawrence, Kans.

P. W. WOOD, M.A. (Cambridge). Fellow, tutor, librarian and mathematical lecturer, Emmanuel Coll., Cambridge, Eng.

FRANCES W. WRIGHT, A.M. (Brown). Instr., Elmira Coll., Elmira, N. Y.

*To institutional membership.*

SAINT BENEDICT'S COLLEGE, Atchison, Kansas.

UNIVERSITY OF CINCINNATI, Cincinnati, Ohio.

EAST TEXAS STATE NORMAL COLLEGE, Commerce, Tex.

The Board granted authority to the Association members residing in Texas to organize a Texas Section. Professor H. J. ETTLINGER has been elected chairman and Professor J. L. RILEY secretary-treasurer of the temporary organization.

The nomination of Professor E. R. HEDRICK, which had been made for one year from June 11, 1920, as the Association's representative on the Executive Committee of the Division of Physical Sciences, National Research Council, was extended to a term of three years from that date.

The Board voted to present the name of Professor E. H. MOORE to the Council of the American Association for nomination to the office of president for 1921. Supported by similar action taken by other affiliated organizations, Professor Moore was elected to the presidency at the Thursday morning meeting of the Council.

At the meeting of the incoming Board of Trustees Wednesday afternoon, the following were appointed Associate Editors of the MONTHLY for the year 1921:

ALBERT A. BENNETT,	WALTER B. FORD,	ULYSSES G. MITCHELL,
EDWARD L. DODD,	CUTHBERT F. GUMMER,	CHARLES N. MOORE,
OTTO DUNKEL,	HENRY P. MANNING,	DAVID E. SMITH,
BENJAMIN F. FINKEL,	RAYMOND B. MCCLENON,	HORACE S. UHLER.

Other business was outlined in reference to the office of the editor-in-chief and with regard to the basis for exchange in the payment of dues by foreign members.

ANNUAL BUSINESS MEETING OF THE ASSOCIATION.

The secretary-treasurer announced the names of those elected to membership by the Board. He reported also the death, in 1920 with one exception, of the following members:

MAE LYNETTE ALDRICH, Professor of mathematics, Martha Washington College (February 22);

G. E. FISHER, Professor of mathematics, University of Pennsylvania (March 28);

Y. H. HO, Fellow, graduate school, Cornell University (February 22);

R. S. LAWRENCE, Professor of mathematics, Hanover College (January 30, 1919);

O. A. RANDOLPH, Associate professor of physics, University of Colorado (April 11);

WILLIAM RINCK, Professor of mathematics, Theological School and Calvin College (November 11);

E. W. STANTON, Dean, Iowa State College (September 12).

On motion of Professor Karpinski the following resolution was voted:

“Resolved, that the Mathematical Association of America favors the national use of the meter-liter-gram system. The Association respectfully urges upon Congress that steps be taken to make the use of this system national in character and in particular that scientific departments of the government be required to use this system.

The election of officers for the year 1921 was conducted by mail and in person at this meeting, as provided in the By-Laws. The tellers (C. N. MOORE and W. L. HART) reported the result of the balloting, the noteworthy number of 454 ballots having been cast:

For President: G. A. Miller, 246 votes; E. J. Wilczynski, 208 votes.

For Vice-Presidents: R. C. Archibald, 307 votes; R. D. Carmichael, 247 votes; Elizabeth B. Cowley, 120 votes; Helen A. Merrill, 224 votes.

For additional members of the Board of Trustees (to serve until January, 1924):

A. A. Bennett, 205 votes; W. H. Bussey, 163 votes; Florian Cajori, 358 votes; E. L. Dodd, 107 votes; C. F. Gummer, 175 votes; H. L. Rietz, 283 votes; W. H. Roever, 176 votes; D. E. Smith, 318 votes.

The following were accordingly declared elected:

President: G. A. MILLER, University of Illinois.

Vice-Presidents: R. C. ARCHIBALD, Brown University; R. D. CARMICHAEL, University of Illinois.

Additional members of the Board of Trustees: A. A. BENNETT, University of Texas; FLORIAN CAJORI, University of California; H. L. RIETZ, University of Iowa; D. E. SMITH, Columbia University.

Because of the election of Professor Carmichael as vice-president, the Board of Trustees, in exercise of its constitutional authority, appointed to the vacancy in the Board for the term ending January, 1923, Professor C. F. GUMMER of Queen's University, as a representative of our Canadian constituency.

The secretary-treasurer made his financial report for the year, giving an account of all business transacted for the Association up to December 2, 1920. The report of the auditing committee (Mrs. MAYME I. LOGSDON, H. E. SLAUGHT, and F. M. MCGAW, chairman) was then made. The financial report is printed in full below.

If to the balance on 1920 business shown in this report, \$3,234.37, there be added the amount of bills receivable, \$165.00, and there be subtracted the estimated amount of bills payable, \$2,040.00, there results an estimated final balance on 1920 business of approximately \$1,360. It will be recalled that, of this surplus, about \$1,000 was passed over to the association by the management of the MONTHLY when the Association was organized five years ago, and this fund is kept by the Board of Trustees of the Association as a reserve fund. If the estimated balance of \$1,360 be compared with the corresponding figure of one

year ago, \$2,040 (See MONTHLY, March, 1920, p. 112), it will be seen that there is a probable deficit on the year's business of nearly \$700, a fact forecast in the report made at the summer meeting and noted in the MONTHLY for November.

# REPORT OF THE SECRETARY-TREASURER AS TREASURER, DECEMBER 2, 1920.

RECEIPTS.	EXPENDITURES.
Balance Dec. 15, 1919.....\$4,581.07	Publisher's bills (Sept. '19-Oct. '20)..\$4,720.10
1917-19 indiv. dues.....\$ 147.90	President's office..... 46.16
1919 instit. dues..... 7.25	Manager's office..... 22.19
1919 subscriptions..... 3.00	Editor-in-chief's office..... 585.45
1920 indiv. dues..... 3,171.66	Other editors' postage..... 10.10
1920 instit. dues..... 359.30	Secretary-Treasurer's office:
1920 subscriptions..... 517.85	Postage.....\$ 99.77
Initiation fees..... 324.00	Bond..... 5.00
Sale copies of MONTHLY... 104.92	Office supplies..... 24.48
Sale reprints..... 1.95	Express, telegrams, etc.... 10.27
Advertising..... 632.52	Clerical work..... 217.75
Exchange..... .50	Printing 1919 Register... 269.62
Interest State Savgs. Bk... 78.20	Printing..... 215.76
Interest Peoples Bk..... 58.13	New York meeting..... 106.16
Interest Liberty Bonds.... 32.49	Chicago summer meeting . 43.00
	Paid to sections from initia-
	tion fees..... 59.31
Total 1920 receipts.....\$5,439.67	\$1,051.12
Total assets up to 1921 business....\$10,020.74	<i>Annals</i> subvention..... 275.00
	Services and fees for incorporation... 76.25
Total expenditures..... 6,786.37	Total expenditures.....\$6,786.37
Balance to the end of 1920 business..\$3,234.37	Cash on hand.....\$ 20.64
Received on 1921 business (including	Checking account..... 601.50
\$33 contributed to 1921 expenses) . 547.39	State Savgs. Bk. Co. account..... 1,247.48
Book balance Dec. 2, 1920.....\$3,781.76	Peoples Bkg. Co. account..... 912.14
	Liberty Bond..... 500.00
	Victory Bond..... 500.00
	Bank balance Dec. 2, 1920.....\$3,781.76

When the accounts were closed on December 2, 1920, in order to furnish the auditing committee a complete record, there remained on the total business for the year 1920 the following items:

BILLS RECEIVABLE.	BILLS PAYABLE.
	(Either paid in December or estimated.)
Advertising.....\$ 80.00	Publisher's bills (Nov.-Dec.).....\$1,250.00
1920 dues unpaid..... 75.00	December <i>Annals</i> subvention..... 50.00
Interest Liberty Bonds..... 10.00	Init. fees due to sections..... 100.00
	President's office..... 50.00
	Manager's office..... 20.00
	Editor-in-chief's office..... 150.00
	Secretary-treasurer's office..... 125.00
	Printing prelim. and annual ballots,
	program, etc..... 225.00
	Additional postage..... 70.00
	\$2,040.00
\$165.00	

On account of the financial outlook a special letter was sent to the members of the Association in October, announcing the new membership dues and the need for subsidiary funds. It is our hope that the appeal for special contributions for 1921 expenses will not be forgotten as members pay their dues, for it is chiefly on this that we rely to offset the decrease in the reserve fund of the Association. It is gratifying to note here that a generous gift of \$45.50 from President Smith and of \$10.00 from Teachers College covers the expense of an effective campaign for members in America and in Europe, an expense that would otherwise fall directly on the Association treasury. It should also be noted that of 400 members who had paid their dues for 1921 before January first, sixty have made special contributions ranging from one up to seventeen dollars, a total thus far of \$150.

While doubtless some may feel that they cannot do more than to pay the increased dues, it is within the range of possibility for almost any member to secure at least one new member; this in itself is a very helpful contribution to the finances of the Association and a real service to those not yet affiliated with the Association.

W. D. CAIRNS, *Secretary-Treasurer.*

## ACOUSTIC CIRCLES.

By H. M. DADOURIAN, Trinity College.

The determination of the position of enemy artillery by *sound ranging* is one of the most interesting examples of the application of science to modern warfare. This consists in observing the time of arrival of the report, or the muzzle wave, of the enemy gun at a number of observation posts of known positions and then in using the *phonotelemetric* data thus obtained to determine the position of the gun. One of the simplest methods used in sound ranging is the following, known as the *method of concentric circles*.

Let  $P$ , Fig. 1, denote the position of the enemy gun;  $O_1, O_2$ , etc., the positions of the observation posts at which the apparatus used for registering the arrival of the sound wave is placed; and  $T_1, T_2$ , etc., the times at which the sound wave

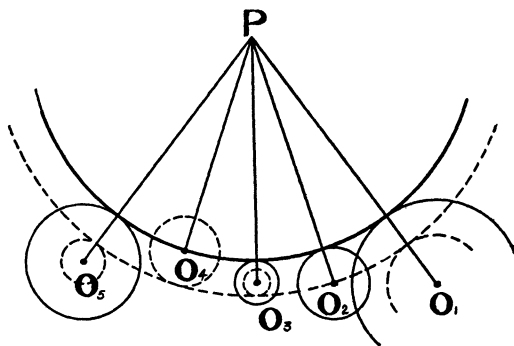


FIG. 1.

reaches the posts  $O_1, O_2$ , etc., respectively. Furthermore suppose  $P, O_1, O_2$ , etc. to be in the same plane, with no intervening objects to obstruct the free propagation of the wave with uniform and constant velocity. Then it is evident that when a spherical wave originating at  $P$  reaches the nearest post  $O_i$  ( $O_4$  in